ON SOME ADDITIONAL LABYRINTHODONT FOSSILS FROM THE HAWKESBURY SANDSTONES OF NEW SOUTH WALES.

(*PLATYCEPS WILKINSONII*, AND TWO UNNAMED SPECIMENS.)

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(Plate XXII.)

In a previous paper (read Sept. 29), on a Labyrinthodont fossil from Biloela (p. 331 of this volume), some expression was given of an expectation that more remains of the same character would be forthcoming before very long. But the writer was nevertheless rather astonished to learn (Nov. 30), from Mr. C. S. Wilkinson, Government Geologist of N.S.W., that a 'Baby Labyrinthodont' had just been met with in a cutting on the Northern Railway, and to have his anticipations so suddenly realized. Besides this fossil there have turned up, among the collections of the Geological Survey Department, two others, one, an unmistakable fragment of the jaw of a large Labyrinthodont, with teeth so much weathered away as to display their internal structure; the other, a portion of a smaller individual, showing the proximal portions of some 8 or 9 ribs, together with the vertebræ to which they belonged, and with considerable remains of integumentary structures, which seemed to the writer to indicate that it also belonged to the Labyrinthodont type. Of this more anon. Confining our attention in the first instance to the 'Baby Labyrinthodont,' it is worth while to state, for the information of collectors, and as helping to determine the exact horizon of the deposit, that this extremely interesting fragment was discovered during the excavations upon the railway now

in process of construction between the Great Northern and Sydney, at a point near Gosford, a well-known village on Brisbane Water, the northern arm of Broken Bay. Together with it were found large numbers of *Cleithrolepis*, *Palœoniscus*, and many other ganoids as yet undetermined.

The Matrix of these specimens is a light grey micaceous shale, belonging to one of those beds of similar character which are frequently intercalated in the Upper Hawkesbury rocks. This particular piece contains fragmentary plant impressions, of ferns and *Phyllotheca*, a nearly perfect specimen of *Cleithrolepis*, the body and tail of a *Palœoniscus* (both of them species well-known as belonging to the Wianamatta formation in N.S.W.), and above all the interesting stranger now for the first time introduced to our acquaintance. This fossil exhibits, as I shall afterwards point out in detail, the head, the shape of which may be compared to that of *Platycephalus*, the throat- or thoracic- plates, and the vertebræ and ribs of the trunk. The tail is broken off by the unfortunate fracture of the stone.

The Head has the upper surface exposed, and is parabolic in outline, rather squarely convex to the rear, displaying large oval orbits, a parietal foramen, and (probably) one nostril; it is covered with bony plates, which are obscurely sculptured in very faint relief.

The Thoracic plates are whitish or chalky in appearance, owing to the presence of calcite in their radiating furrows. They look as if they belonged to the upper and not to the lower surface of the animal. But they correspond so exactly with all that is recorded as to the Thoracic plates of the Labyrinthodonts (Miall, Report Brit. Ass. 1873, p. 241; Owen, Palæontology, p. 179; Lydekker, Palæontologia Indica, Ser. IV. Vol. I. &c., &c.) that one must regard them as belonging to the ventral face, for on close examination it may be seen clearly that the medial shield overlaps the inward margins of the laterals; whereas, as seen from the outside, "it is overlapped by the lateral plates to a considerable extent, especially upon the antero-external borders; and frequently only the hinder part is exposed," (Miall, l.c.) and

"the outer surface is sculptured by radiating furrows, except at so much of the marginal part as is overlapped by the lateral pieces." (Owen, l.c. p. 179). This fact of course shows that we have the upper or inner face of these structures exposed, and that their external or downward aspect is hidden. It follows then that, while we have the upper surface of the Head preserved, the anterior part of the vertebral column, and the whole upper surface of the body have been more or less engaged in the counterpart stone, which is lost; that we see in our specimen the interior surface of the Thoracic plates displayed by the removal of the upper part of the body; and have a view, from above, of all the vertebræ and ribs, except some few of the anterior joints, as far as, and including, the indications of a pelvis or equivalent support for a weak hinder limb. The Amphibian, therefore, lies flat upon its belly, while the fishes which are associated with it on the slab are naturally laid flat upon their sides.

Before proceeding further it must be clearly understood that the greater part of the details which I am about to describe cannot be made out by a hurried observation, nor even by the most careful examination if made on one single occasion. The varying illumination which we receive under various conditions of the atmosphere is found, in such almost obliterated inscriptions, to bring out from time to time particulars of form, relief, sculpture, and colour which otherwise, as under a perfectly clear sky and in bright sunlight, remain invisible. Points and lines which become clearly distinguishable, if not distinct, at one moment, seem to vanish as suddenly as they appear, and one may look in vain to-day for forms which yesterday might be measured and drawn without difficulty. It follows that the figure which accompanies this paper is fairly entitled to an amount of consideration which one would not presume to claim under circumstances of a less perplexing character, and that it should be judged not upon a single comparison with the original, but after a long series of examinations on different days, and at different hours. It is not probable that many persons will take this trouble. Nor indeed is it necessary. If these drawings are correct, or so far as they are

correct, they will be supported by the evidence of the future, since we may fairly expect that many additional specimens of Labyrinthodonts will be in our hands before long.

The Head, which is about 27 mm. in length, by about 32 mm. in breadth at the base, is crushed flat, or even rather hollow, although the parietal, quadrato-jugal and occipital bones, and the rim of the orbit, remain in low relief. The parietal foramen, and the two orbits, are distinct enough, though the left hand anterior portion of the rim of the left hand orbit has been broken away, and a part of the opening filled by a small fragment of bone, either extruded from below, or slipped from the side. One of the nostrils, the right, may, I think, be observed near the anterior margin and medial line; the other has disappeared. The left mandible lies outside and clear of the jugal and maxillary bones. A portion of the right maxilla is also preserved, and the anterior margin of the frontal (?) is well marked, The posterior left hand angle *seems* as if it ought to have the quadrato-jugal united with the supra-temporal, and that with the postorbital and squamosal, but, as even with the utmost effort I fail to determine any sutures, I only make a conjecture to that effect. This part is sculptured with shallow traces radiating from the angle, and there is a depression or half-pit just inside the angle, as if at the angle the bone had resisted a pressure which was sufficient to break down the soft material to the right of it. This additional strength at the very angle may have been due to the articulation of the lower jaw directly below it. (1) The parietal bones are obviously marked out by the foramen, from which similar traces of shallow pits radiate in all directions, but mainly forwards and backwards. The super-occipital ends abruptly backwards, as do the other bones of the posterior margin of the head, as if their hinder portions had been in a cartilaginous condition, and had so missed complete preservation; although, indeed, in the furrow which thus abruptly terminates the occipital region, there are seen

(1) Can this be referred to the 'internal articular buttress' of the Mandible?

two irregular protuberances about 10 mm. apart; which I suppose to indicate the epiotic cornua in a quasi cartilaginous condition. Between them, I have once or twice thought, but hesitate to say, that one of the two condyles was to be made out, in an equally imperfect state. The appearance which suggested this may, however, be really a trace of the atlas.

Miall (l.c. p. 229) states—"That in Labyrinthodonts of the carboniferous the occipital region appears scarcely ever to have been ossified, and that owing to its cartilaginous character, it has left little or no record." "In the Triassic Labyrinthodonts," he continues," "the occipital region was fully ossified." But not, I presume, in individuals so young as ours.

Dimensions of Head.

Length (about)	27 mm.
Breadth „	32
Distance of orbit from base of skull	10
Least width of interorbital space	8
Length of orbit	8
Width of orbit	6·5
Distance of parietal foramen from base of skull	8
From centre of occiput to posterior end of orbit	14
From tip of snout to anterior end of orbit (about)	9

It is probable that these proportions of the skull would have been different if the animal had attained a higher degree of development. For as Miall says (l.c., p. 233.) "Like all the bones of the face not only in Labyrinthodonts but in vertebrata generally, the nasals become longer and longer relatively to the brain case as age advances. This is notably the case with long-snouted animals, such as the Crocodilia, and is most apparent in those species of Labyrinthodonts which have elongated skulls." And again, "as the parietals lengthen with age the (parietal) foramen is placed further and further back in the interparietal suture" (ib. p. 234). In this case the foramen is about 8 mm. in advance of the centre of the occiput, and about 2 mm. behind the line joining the hindmost points of the orbits.

If—as seems reasonable—we consider the relative positions of the posterior angles, the parietal foramen, and the orbits to be of a more permanent character than those which are subjected to continued and increasing differentiation with increase of age, and compare this 'triangulation' with the figures given by Miall (Rept. 1874, p. 192, Pl. IV.-VII.) we shall discard, as being in these respects remote from our example, the following types:—*Mastodonsaurus*, *Trematosaurus*, *Metopias*, *Brachyops*, *Rhinosaurus*, *Loxomma*, *Batrachiderpeton*, *Pteroplax*, *Keraterpeton*, and retain *Capitosaurus*, and even the very elongate *Archegosaurus*, as more nearly related. *Capitosaurus*, it will be remembered, is the genus to which the Biloela fossil seems referable. (*Archegosaurus*, besides its Permian character, can hardly have had its cranial region, even in its youngest forms, and considered apart from its facial bones, so broad and squat as this before us). On the other hand, indeed, if we follow the Tabular View (Miall. l.c. p. 149) it will be placed in Section II., BRACHYOPINA, along with *Brachyops*, *Bothriceps*, *Micropholis*, and *Rhinosaurus*. Yet, referring to the Analysis of Characters (ib. p. 174) we find the following notes of the mature *Capitosaurus* combined in this immature example, viz.: —Skull broad; orbit oval, large, (1) posterior; interorbital space greater than transverse diameter of orbits; mandible with internal articular buttress (?); thoracic plates externally sculptured, lateral plate with reflected process (?).

These considerations lead us to search among the genera most nearly approaching to *Capitosaurus* for the adult form of which our fossil is an immature representative. It is very possible that this particular form may be as yet undescribed. But *Bothriceps* (described by Huxley, Q. J. G. S. XV. p. 647) is Australian, though its particular locality is not known, and therefore has a certain claim upon our consideration. There is only one species known, *B. australis*, and this seems to differ in some important points from our fossil. For the snout is more pointed (or the head more

(1) Ambiguous character. The orbit is *large* in proportion to length of skull, which is a variable.

triangular), the greatest width is more in advance, the parietal foramen is much further behind the orbits, and the anterior suture of the frontals far more forward than its *apparent* position in our specimen. The sculpture of the head, from which the name is derived, is in the form of detached and promiscuously scattered pits, whereas in ours it shows traces of regular and radiate arrangement. Moreover, if we denote the greatest breadth of the head by the co-efficient 100, since that dimension may probably have more stable relations to the distances of the orbits and foramen from one another and the occiput, we obtain the following table of comparison:—

	Bothriceps Australis.	*Platyceps Wilkinsonii.*
Greatest breadth	100	100
From centre of occiput to posterior end of orbit	115	43
Length of orbit	61	25
Width	46	20
Least width of interorbital space	34	25

The relative distances of the 'foramen' from the orbits I have not calculated, but judged from the eye. As I cannot refer this fossil to any previously described genus, I am induced to give it, provisionally, and only for the sake of convenience, a name of its own, although it savours somewhat of rashness to found a genus upon a specimen in so low a stage of development. I propose, therefore, to call it *Platyceps Wilkinsonii*, the specific name being given in honour of our respected Vice-President, Mr. C. S. Wilkinson, F.G.S., &c., by whose kindness I have been enabled to submit the specimen to a prolonged examination.

[Lydekker, however, in his description and figures of the Bijori Labyrinthodont, *Gondwanosaurus Bijoriensis* (Pal. Ind. Ser. IV., Vol. 1, pt. 4.) touches on so many points which are, to say the least, illustrative of this specimen, that I am induced, *secundis curis*, to give a brief account of his statements and conclusions, as they fall in with the course of this paper. The head of *Gondwanosaurus* then, to begin with, is elongate, being about half as long again as broad. But the value of this character

depends so much on the age of the individual, that it becomes of minor importance in a comparison between individuals of different ages. The relative position of the orbits, parietal foramen, and quadrato-jugal angles corresponds well enough, especially if we admit that along with the prolongation of the facial bones the articulation of the lower jaw was also gradually thrust further and further to the rear. 'The degree of backward extension of the Quadratojugal varies greatly, according to the species, and, in *Archegosaurus*, according to the age of the individual.' Miall. l.c., p. 235.]

The 'Lyra,' consisting of paired muciferous (?) canals running more or less longitudinally along the surface of the cranial bones, is rather obscure and often escapes the eye. It may however be seen upon the left squamosal, near its probable junction with the parietal, and curving slightly forwards and outwards to the posterior margin of the left orbit. I cannot make out whether it is here evanescent or whether it continues without interruption to the place where it may again be made out passing round the inner side of the orbit, and so forwards. The only sutures between cranial bones which I can see (or perhaps imagine) is that between the left post-orbital and quadrato-jugal bones, and that between the right frontal and pre-frontal. The frontal bones are sculptured with shallow longitudinal pits, and similar furrows run from the parietal foramen backwards as has been hinted above. There is no sign of teeth.

[In *Gondwanosaurus*, the dentary piece of the mandible bears a row of *small*, acute, and subcylindrical teeth. It also laps outward from beneath the jugal and maxilla so that the head is slightly 'underhung' in the same manner as in our specimen.]

The Vertebræ are all alike, so far as I can see. If the neural spine was ever ossified, it has been removed in the counterpart. The two small knobs, paired right and left, which represent each joint, seem to be the rudiments of the neural arches and transverse processes. They exhibit some chalky markings, and other indications of form which may be capable of interpretation by skilled

observers. The centrum seems to have been only cartilaginous. At least I can see no trace of it. [In *Gondwanosaurus*, each vertebra consisted originally of a bony neural arch, from which a bony plate descended on each side, and joined a median ventral portion. The intervening inferior portions of the column being represented by unossified remains of the notochord.] The Vertebræ number sixteen (16) from the posterior termination of the medial plate, to the indication of a pelvis. There is no appearance of a sacrum. It appears as if the number of vertebræ in advance of the posterior end of the throat plate was eight (8), and these, together with their appendages, seem to have been in the process of fossilisation crushed down into, and amalgamated with, the thoracic plates which lie beneath them. For it can hardly be questioned, as shown above, that we have the inner or upper surface of these plates exposed, that is, that the spinal column lies between them and our eyes, and that consequently any portions of the spine which may, from whatever cause, appear to be beneath this inner or upper face are nevertheless in reality above it, although perhaps sunk into or through the surface. Some such portions of these anterior vertebræ, similar in every respect to those behind them, are quite distinctly visible, and appear, the ribs especially, as if they lay in an impossible situation beneath them. I can only suggest, as a possible explanation of this contradiction, that the process of mineralization, by which calcite has been deposited in the radiations of the plates, has also effected a similar deposition in the slight and scarcely solid bones which were pressed down upon them.

[On second thoughts I am led to the conclusion that the ribs and vertebræ, which seem to stand out in low relief upon the surface of the plates, and nevertheless to be crossed by the white lines of calcite as if they were seen through their substance, are in reality impressions in relief from Moulds in intaglio formed by the shrinking or flattening of very imperfectly ossified bones or cartilages; and that thus these reliefs are casts, or squeezes, in the soft and thin but horny material of the plates, these being pressed upwards into the aforesaid Moulds.]

Ribs are attached to all the vertebræ, including those two which the specimen retains behind the pelvis, or its indication. I can best describe them by quoting direct from the Report often cited above (Brit. Ass. 1873, p. 240.) "As to form they are usually compressed (transversely to the axis of the trunk) at either end, but are nearly cylindrical in the centre of the shaft. They are short, relatively to the probable dimensions of the thorax and strongly curved. A capitulum and tuberculum are present in all well preserved examples. Both articular surfaces are slightly concave and adjacent, and appear to have articulated with the vertebral transverse process; a notch or groove commonly separates them, and is usually continued for some distance along the shaft of the rib." Except for the 'strong curvature' of the ribs, (1) the above description will be seen to correspond with singular closeness to the specimen before us, if we take into consideration the extremely immature and almost embryonic condition of its ossification in general, together with the following remarks upon *Archegosaurus* (l.c.) "Some very young examples afford evidence of cartilaginous vertebral extremities, this evidence consisting of the separation of the proximal ends of the ribs from the vertebral column by a regular interval, and the hollowing out of the ends as if in conjunction with cartilage; at this stage a transverse process may be seen to project for a short distance from the lamina of the corresponding superior arch." Though this account could hardly have been established upon our specimen, yet it is plain that the specimen follows the diagnosis with curious fidelity. The true head and tubercle of each rib, and the approaching portion of the transverse process were evidently cartilaginous and have quite disappeared.

[In *Gondwanosaurus* the ribs display the general Labyrinthodont character—expansion at the two extremities, and articulation with the transverse processes of the vertebræ by a distinct capitulum and tuberculum.]

(1) Owen, Palæontology p. 172, describes the ribs of *Archegosaurus* as "short, almost straight, expanded and flattened at the ends, round and slender in the middle."

Just in advance of the right thoracic plate a wedge-shaped bone, perhaps belonging to the hyoid arch, is visible, but indefinite; while on both sides, and partly between the plates and the posterior angles of the head there appears a set of three or four parallel 'rows of ossicles' more or less united in continuous lines, and slightly curving forwards and inwards. These latter unquestionably represent the Branchial arches, and serve as another indication of the very early or low stage of development to which this individual had only just attained at the time of death.

The Thoracic plates, as has been already shown, are seen from above, that is to say, their inner or upper surface is exposed to view by the removal of whatever structures may have lain within or above them in life. They are extremely thin, like fish scales, and are ornamented with radiating furrows, which are whitened by a deposit of calcite; those of the laterals showing through the rays of the overlying medial as if they intersected them. One can also discern, as has been before stated, traces of the anterior vertebræ, with the ribs appertaining to them, so pressed down into, and so united with, the substance of the plates, that it seems as though the spinal column passed along their further surface. [Another and better explanation is given in a preceding note.]

Their form may be thus roughly described:—The Medial is pentagonal; the anterior half is triangular, nearly equilateral, with the apex a little rounded. The posterior half is bounded by three sides, the middle being the shortest. They are all concave or emarginate, and the angles between them are rounded. The sculpture radiates from the centre of the shield.

The shape of the Laterals is not so readily determined or described; it must suffice to say that the general shape is oval, the broad end in front, and that they converge towards the same point, not, however, quite meeting, but having the angle between them closed by the anterior apex of the overlying medial. The sculpture of the laterals radiates from their external angles, which are very obtuse, and are a little in rear of the centre of the medial.

The outer flanges of the lateral plates ("reflected process") appear to be continued backwards beyond the points from which the furrows radiate, and which may be called their centres of ossificati on. These prolongations seem to be distinct bones, and may perhaps be supraclavicles, as in the figure of the plates of *Gondwanosaurus*, Lydekker, Pal. Ind. Ser. IV. I. 4. At each centre of ossification is a pit, with a tubercular (?) centre, where I suppose the scapula and coracoid to have approached, if not articulated with, the thoracic plates or clavicules. The coracoid, however, is lost, like the scapula, or was perhaps only cartilaginous and has left no sign. At the outer angles of these laterals are some scattered fragments which may possibly belong to the shoulder girdle.

Their dimensions are as follows :—

Medial Plate.

Length	15 mm.
Width (about)	13
Length of each anterior margin	11
Length of each lateral margin	9
Length of the posterior margin	6

Lateral (Left Side.)

Length from centre of radiation to anterior margin (about)	11
Greatest width (about)	6

[In *Gondwanosaurus* the thoracic plates appear to be identical, though, of course, in a much more advanced stage of development, with those of our specimen. "The central plate or interclavicle is imperfect posteriorly, having been broken off posteriorly to the central point from which the sculpture radiates; this missing portion has been restored in outline in the figure." But in our specimen the plate, though perfect, is truncate and emarginate posteriorly, and the same may have been the case with the Bijori fossil. "When complete this plate formed an unsymmetrical rhomboid, covered with a sculpture consisting of elongated pits radiating towards the periphery from a centre situated at the junction of the maximum longitudinal and transverse diameter.

The size of the pits increases regularly from this centre to the periphery. The lateral plates or clavicles are irregularly triangular in form and largely overlap the anterior portion of the interclavicle; although apparently not meeting in the median line. The external angle is the thickest portion of the lateral plate, and from this point there radiates a sculpture very similar to that of the median plate. The bone is sharply flexed at the external angle, beyond which it is produced into a slender process which is in apposition with a slender and but imperfectly preserved bone, termed by Prof. Gaudry the supra clavicle (sus-claviculaire). Fragments of other bones are seen lying in a deeper plane at the posterior border of the thoracic shield which doubtless represented other elements of the shoulder girdle, but they are too imperfectly preserved to admit of determination; although one of them may very probably correspond to the coracoid." The figures which Lydekker gives of the thoracic plates correspond exactly, except in the greater maturity of their development, and therefore in their size, excepting also the doubtful restoration of the medial, with the characters of our specimen. But in both figures (Plate 3 and 4), the *ventral* aspect is represented, showing the medial overlapped by the laterals, instead of the laterals being overlapped, as in the dorsal aspect, and in this specimen, by the medial. I may observe that in plate 4 the figure is upside down, the anterior portion being turned towards the bottom of the page.]

The sixteenth vertebra, counting from the posterior edge of the medial plate carries on the right hand side of it a bone in the position of the proper rib, and differing from the other ribs, at least at the proximal end, only in size, having the head nearly twice as broad as theirs. The shaft appears to expand towards the distal extremity, but is imperfect. Of the corresponding bone on the left side only the head is preserved.

The next vertebra is more closely approached on both sides by a pair of bones, which are very imperfect, and are smaller than the preceding pair. It is quite possible that a little clearing of the matrix might give us more information here, at least on the right hand side. But I religiously refrain from tampering with the goods of which I am only 'bailee.'

These enlarged and altered ribs appear to correspond with those observed in *Menopoma*, and, the anterior pair, with those of other Urodela, except *Proteus* and *Amphiuma*, their distal ends abutting against, and being united by ligaments with the ilia. (Encycl. Brit. s. v. Amphibia, T. H. H.). Nothing appears to be known of the structure of this pelvic girdle in any other Labyrinthodont than *Archegosaurus;* and it is interesting to observe the approximation of our subject in this respect to amphibians now in existence. It is possible that some traces of bone about the distal extremity of the first sacral rib may represent other portions of this girdle. But the supporting rays in both pairs of limbs would seem to have been entirely cartilaginous, since there is no trace of either humerus or femur, which, if at all ossified, would surely have been preserved, inasmuch as the whole animal was evidently quietly buried, and without any mutilation or decomposition. Such limbs could not have supported the creature upon land; and indeed the slightness and weakness of the pectoral and pelvic girdle tell the same story. It must therefore have been aquatic, furnished with four paddles, but probably depending mainly upon the tail for locomotion. And this perhaps larval condition corresponds with the distinct presence of branchiæ, and with its situation as a fossil, in the exact place where it, with the fishes swimming about it, was by some means or other put to sudden death, and covered up with a layer of micaceous mud.

We may conjecture that animals of this kind, in the toothless condition of their early youth, fed in part at least upon the spawn of the Fishes whose society they seem to have frequented. And the large numbers of the latter which have been found together in the Gosford cutting shows that they used to move about in shoals, a conclusion which also follows from the large numbers recently obtained by Dr. Ramsay, Curator of the Australian Museum, from brickyards near Marrickville, in which the Wianamatta Shales are quarried for the manufacture of bricks. We also see that these fishes, which are all of them Ganoids, lived in quiet lagoons with muddy bottoms, which were formed, in Triassic times as at present, by shifting of the great river courses, and which then, as

now, are liable from time to time to an invasion of flood waters from the main channel. And we are, perhaps, not presuming too much on these analogies when we conjecture that such shoals of fish, thriving in the tepid waters of these lowland lagoons and anabranches, and associated with Labyrinthodonts in these habitats, may frequently have been killed in large numbers by a sudden irruption of cold, perhaps icy, waters and mud which at once destroyed and preserved them. It may be observed that the Dipnoi, *Protopterus*, *Lepidosiren* and *Ceratodus* which claim some sort of relationship to these amphibia, all belong to warm climates and tepid waters; and that the only Ganoids now existing belong either to temperate and sub-tropical regions, like *Lepidosteus*, or to tropical and sub-tropical, like *Polypterus;* facts which seem to indicate an adaptation, at least, to such conditions as those under which our Triassic rocks were formed. I suppose also that the strong head and throat-plates of the Labyrinthodonts, as well as their hard dermal scutes or indurated integument, like the ganoid scales of *Palæoniscus*, *Lepidosteus*, &c., the cuirass of *Pterichthys* and *Coccosteus*, (1) the bucklers of *Acipenser*, and the rugged mail of the Crocodiles, bear all of them a certain relation or accommodation to fluviatile habitats. These animals all live, or appear to have lived, in great rivers with strong and irregular currents, and subject to sudden inundation by freshes, in which heavy materials, such as stones and logs, might be carried along with a velocity dangerous to any organism upon which they might strike. Some protection was manifestly requisite for the welfare of aquatic animals exposed to such perils, and it was obviously desirable, in their interests, that this protection should be such that external hardness and stiffness should be accompanied by internal elasticity and toughness. and that brittleness of any structure should especially be avoided. All these conditions are united for Labyrinthodonts in the deeply corrugated or pitted plates of bone and the hard scutes or studs which lay immediately beneath the

(1) I assume that the conditions under which the Old Red and the New Red Sandstone were deposited to have been closely analogous, if not identical in character.

skin, which clothed it, and in the cartilaginous state of the skeleton, beyond which few of them advanced. For these characters all harmonise with the object in view. Perhaps one might even add, as a concomitant variation towards the same end, the strangely complicated structure, trussed, braced, and compensated, of the Labyrinthodont tooth.

The second specimen which is exhibited this evening is from Bowral, from the Wianamatta Shale. This fragment is so impregnated with iron as to make a good ore. It appears to be a portion of a maxillary bone, is about 2 inches in length, and bears the remains of five teeth much weathered and broken. They were set very close to one another, and may have been about three-quarters of an inch in length, with a diameter at the base of about ·37 inch. Their material, like that of the bone, has been mainly replaced by transparent calcite. The bone exhibits parallel ridges, and is about an inch in width.

The last specimen of the three is also from Bowral, in a dark indurated shale belonging to the Wianamatta series. It contains portions of 11 vertebræ, with the ribs of the left side. The spinal column is marked by a flattened ridge, well-defined at the edges, about 2 mm. in width, and probably representing the series of neural spines. Some obscure undulations from front to rear may indicate joints.

About the same distance to the left are seen the proximal ends of the ribs, not less than 4 mm. in width, though perhaps expanded by pressure. The ribs were hollow, and are now principally filled with calcite, a narrow streak of which is also visible along the spine. Miall on *Hylonomus* (Report 1874, p. 173) describes similar ribs, and gives a note from Owen upon them, in which it is shown that the cavity was not properly a medullary one, but was posthumous, and due to the solution of the primitive cartilaginous mould of the bone, which had remained unchanged by ossification in the living species. He concludes that these bones were originally solid, and composed, as in most amphibians, of an osseous crust enclosing cartilage. Their shape is peculiar, probably

owing to distortion. The head portion is nearly a right-angled triangle, with the perpendicular 4 mm. in length parallel to the spine, the base, about 5 mm., curving gradually to the rear, and the hypotenuse, about 7 mm., bending towards it at an angle of about 40.° The shafts then bend backward, so as to become more or less parallel with the spine, for about 17 mm., and are consequently in close juxtaposition. They then bend outward, about 10 mm., and so disappear.

It is not easy to account for this double curvature of the ribs, unless some such twisting of these curved bones has occurred as might result from a forward shift of the upper surface of the fossil, pushing the upper and proximal extremities forward, while the distal and lower remained stationary, or moved in the opposite direction. This would throw any vertical portions of the series of ribs into the same straight line, and would, under the supposition which follows, account for the close approximation of the shafts at about half their length, while it would also, by the attendant vertical pressure tend to make any forward processes spread outwards.

It may therefore be conjectured that each rib diverged from the spine outwards and backwards, but nearly horizontally; that it then bent down nearly vertically towards the ventral aspect; and that finally it curved forwards towards the head. For under such circumstances a gradual pressure from above and behind would produce just such an arrangement as has been described.

Certainly it may be doubted whether ribs of such a character can be Labyrinthodont. Still, the tubular bones, the apparently cartilaginous notochord and the dermal scutes—together with the occurrence of No. 2 in the same beds—offer evidence which must be lodged in the opposite scale. And I do not think anyone will regard this fossil as the remains of a Fish.

The preceding description and argument is based on the assumption that we have the dorsal aspect presented to us. And the whole appearance of the fossil seems to warrant this assumption. But there is a little difficulty in the way, since the remains of the

integumentary scales *overlie* the vertebræ and ribs, while according to Miall (Report 1873, p. 245) this armour is entirely *ventral*. However (ib. p. 246), it is also stated that "granular, shagreen-like scales have been found to cover other parts of the body of a few Labyrinthodonts." If these scales are really ventral, the supposed series of neural spines must be regarded as the representative of the lower face of the notochord. In any case, however, the integument presents a finely granular surface, studded with small scutes, which are arranged sometimes singly or by twos and threes, and sometimes in broad patches. No sort of symmetry in the distribution of these patches is observable, or in their shape; so that one is led to conjecture that these 'scutes' appeared piecemeal with advancing age, and may perhaps have disappeared in the same way. The shape of those which are isolated, and therefore developed without interference, is elliptical, the longer axis being transverse to the spine; the margin forms an elevated rim, which surrounds a depressed area at apparently the same level as the skin outside. When they are grouped in numbers they are either arranged along diagonal lines like the scales of ganoids, the diagonals sloping forwards and inwards, or they are set in quincunx, like shingles on a roof, or scales in ordinary fish, but not overlapping, although a striking resemblance to imbrication is produced by the irregular development of the rim, the anterior portion being little raised, or not at all, while the posterior is even more elevated than in the isolated examples. They remind one forcibly of the dermal papillæ of *Monacanthus*, or of sharks.

These two fossils seem sufficiently hard to allow of transparent microscopic sections being prepared from them; a method which would throw much light upon doubtful and unknown points of structure.